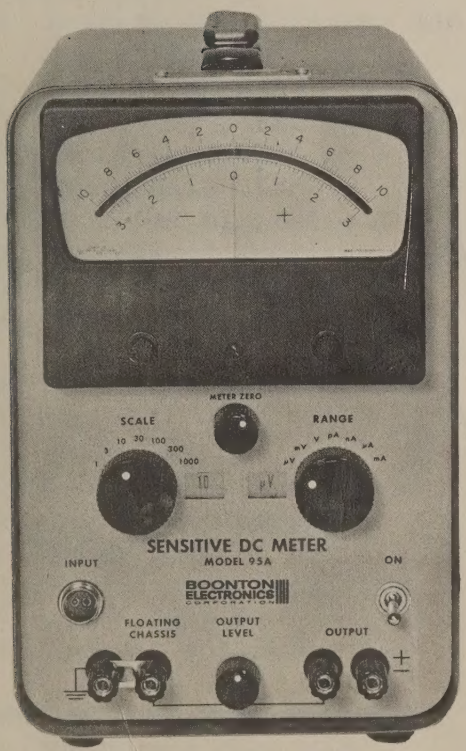
MODEL 95A

SENSITIVE DC METER



INSTRUCTION MANUAL

STABRO LABORATORIES, INC.
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DOCUMENT CONTROL ADMINISTRATOR

95A
c-471

BOONTON ELECTRONICS CORPORATION

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SECTION I

SPECIFICATIONS

Voltage Range	± 1.0 microvolt to 1000 volts dc
Current Range	± 0.1 pA (10^{-13}) to 1.0 ampere dc
Input Capacitance (100 kHz)	50 pF (approx.) without cable 175 pF (approx.) with cable

Input Resistance

Voltmeter: 10 megohms, all ranges

Ammeter: 1.0 pA to 100 pA Range: 10 megohms

300 pA:	3.33 MΩ	1 µA:	1 KΩ
1 nA:	1.0 MΩ	3 µA:	333 Ω
3 nA:	0.333 MΩ	10 µA:	100 Ω
10 nA:	100 KΩ	30 µA:	33.3 Ω
30 nA:	33.3 KΩ	100 µA:	10 Ω
100 nA:	10 KΩ	300 µA:	3.33 Ω
300 nA:	3.33 KΩ	1 mA to 1A:	1.0 Ω

End Scale Ranges

Voltage: ± 10 microvolts to 1000 volts dc

Current: ± 1.0 picoampere to 1 ampere

Accuracy

Voltmeter: ± 3% of end scale

Ammeter: ± 4% of end scale

Ranges

Voltmeter: 17 Ranges 10,30,100, etc. sequence

Ammeter: 25 Ranges 1,3,10, etc. sequence

Noise 1 µV PP (approx.) referred to input

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SPECIFICATIONS (cont'd)

Drift	Less than ± 2μV after 30 minutes warm-up referred to input.
DC Output	± 1 volt across 1000 Ω; one terminal at chassis potential.
Bandwidth	1 cycle at 3 dB
60 Hertz Rejection	Greater than 60 dB
Amplifier	Gain 100,000 maximum
Output:	0 to ± 1.0 volt into 1000 Ω load polarity same as applied input. Output is continuously adjustable.
Output Ripple:	Less than 0.01V RMS
Output Impedance:	Approximately 2000 Ω

Overload Tolerance:

RANGE	OVERLOAD TOLERATED
10 μV to 1 mV	10 V
3 mV	30 V
10 mV	100 V
30 mV	300 V
100 mV to 300 V	1000 V
1000 V	1500 V
1 pA to 100 pA	1 μA
300 pA	3 μA
1 nA	10 μA
3 nA	30 μA
10 nA	100 μA
30 nA	300 μA
100 nA	1 mA
300 nA	3 mA
1 μA	10 mA
3 μA	30 mA
10 μA to 30 μA	100 mA
100 μA to 300 μA	300 mA
1 mA to 1 A	3 A

SPECIFICATIONS (cont'd)

Power Requirements	105 to 125 V, 50 or 60 Hertz; 40 watts
	210 to 250 V, 50 or 60 Hertz; (Special)
Size	
Bench Unit:	7-1/2 W x 10-1/2 D x 11 H
Rack:	19 W x 11-3/4 D x 5-1/4 H
Weight	
Bench Unit:	14 lbs., Net
Rack:	Approx. 22 lbs. packed

SECTION II

GENERAL DESCRIPTION

The Model 95A DC Meter is a combination electronic voltmeter, ammeter, and amplifier. Its dc voltage measuring capability, extending 1.0 microvolt to 1000 volts, is covered in seventeen sensitivity ranges; twenty-five current ranges provide for measurements from 0.1 picoampere to 1.0 ampere.

As a dc amplifier gain of the Model 95A is continuously adjustable up to a maximum of 100 dB, and is capable of providing ± 1.0 milliampere into a 1000-ohm load. The unusual multiplex range selection system makes switching between the 42 measuring ranges an extremely simple, convenient process. The amplifier output can be used simultaneously with the indicating meter without interaction.

For voltage measurements, the input circuit may be operated either grounded or floating. The instrument case and panel are connected through the power line cable to ground. Terminal 1 of the input receptacle is connected to the amplifier chassis which is insulated from the instrument case by approximately 500 megohms. The amplifier chassis may be grounded by connecting a jumper between two terminal posts located on the front panel. For current measurements, the instrument should be operated in the floating condition only. In Model 95A's having serial numbers of 801 or below, the shorting jumper should be removed before current measurements are made. In instruments having serial numbers 802 or above, the ground is automatically disconnected when the range selector is set to any of the current measuring positions, regardless of whether the shorting jumper is in position or not.

The Model 95A is supplied complete with a set of four-foot test leads with insulated aligator clips.

The Model 95A-R is electrically identical to the Model 95A but has been rearranged mechanically for mounting in a standard 19-inch rack.

SECTION III

OPERATING PROCEDURE

IMPORTANT: This section contains information essential to successful operation of the instrument. It should be read carefully before the Model 95A is put into service.

3.1-0 Initial Installation and Turn-On Procedure

After the instrument has been unpacked, it should be inspected for possible damage in transit. If damage is found, contact your local Boonton Electronics Sales Engineering Representative or the factory for instructions. Otherwise, the instrument may be put into service by the following procedure:

Step a. With the instrument placed in a normal operating position, check the rest position of the indicating pointer. If it is not resting at zero, adjust the mechanical zero control as required.

Step b. Plug the line cord into a suitable power source. Important: The Model 95A can be operated only from a power source of the voltage and frequency shown on the instrument's identification plate.

Step c. Connect the test leads to the input jack, turn the instrument on, and allow a warm-up period of at least 10 minutes.

Step d. With the FULL SCALE selector set to 10 and the RANGE selector set to μV, short the two input clips and zero the pointer using the METER ZERO control.

The instrument is now ready for use.

3.2-0 Zero Adjustment

It is advisable to check the meter zero each time ranges are switched, particularly the lower ranges (e.g., below 1mV). When zero is checked, the input should always be shorted.

3.3-0 Grounded Operation

The instrument case and front panel are grounded through the power cable. The chassis is insulated from the case and panel by approximately 500 megohms. For grounded operation, simply insert the shorting link between the two front panel GROUNDED CHASSIS terminals.

3.4-0 Floating Operation

With the grounding link removed, the input is insulated from ground by approximately 500 megohms. The instrument will withstand a dc potential of 1000 volts between case and chassis without damage. NOTE: In instruments having serial number 802 or above, the ground connection is opened internally when the range selector is set to any of the current measuring positions, regardless of the position of the grounding links.

3.5-0 Range Selection

The range selection arrangement of the Model 95A provides 42 combinations of current and voltage sensitivity. (NOTE: A mechanical interlock prevents setting up the unusable combination of either 1 or 3 μV, FS.)

If there is doubt as to the general value of the measurement to be made, it is advisable to switch first to one of the less sensitive ranges, then connect to the test points, and switch down until useful meter deflection is obtained, rather than overload the input.

3.6-0 Overload Limitations

It is important not to exceed the overload limits specified for each combination of FULL SCALE and RANGE settings, as shown in "Overload Tolerance," page 1-2.

While overloads within the indicated limits will not cause internal damage, it should be noted that a recovery time of up to 60 seconds may be required before subsequent measurements can be made.

3.7-0 Sources of Spurious Deflections

When making measurements on the most sensitive ranges of the Model 95A, care should be taken to avoid introducing spurious deflections from external sources. One of the most common of these is a strong, local ac field. While the instrument includes a rejection filter which reduces power frequency pickup by more than 60 dB, it is advisable to avoid using the most sensitive ranges in the presence of strong ac fields.

If this is not possible, the instrument and input terminals should be carefully shielded.

Thermal voltages resulting from temperature differentials across junctions of dissimilar metals can also be a source of unwanted indications. Great care has been taken in the selection of materials and location of parts in the Model 95A to minimize such thermal voltages. Similar care should be taken with the equipment to which the input cable of the Model 95A is connected.

IMPORTANT NOTE

For measurements at maximum sensitivity, the atmosphere should be controlled to contain no more moisture than that present at 75°F when the relative humidity is 50%. Higher humidity may produce a small potential across the insulating materials supporting the input connections and switch contacts owing to contamination which combines with moisture to form an electrolyte. This results in an unavoidable zero shift on the most sensitive ranges which may be outside the range of the zero control.

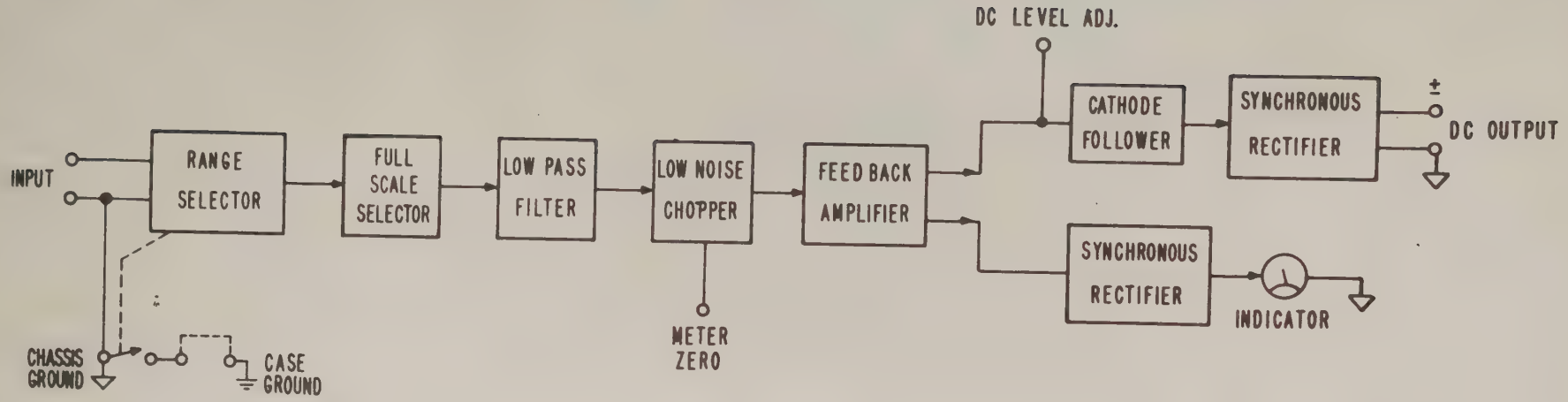
3.8-0 Current Measurements

Important: Current measurements should be made in the floating condition only. In instruments having serial numbers of 801 or below, the grounding link should be removed. In instruments having serial number 802 or above, the ground connection is opened internally when the range selector is set to any of the current measuring positions.

For input resistances of the various ranges of current measurement, see Section I, Specifications, under "Input Resistance, Ammeter."

3.9-0 Amplifier Output

The ± 1 volt dc output of the Model 95A is available at terminal posts on the front panel. This voltage is referenced to chassis potential and may be used to operate a dc recorder or to trip limit relays in an automatic test set-up. The amplifier gain is continously adjustable from 0 to + 100 dB by means of the range switch and the output level control located on the front panel. The amplifier may be operated simultaneously with the dc meter indications.



BLOCK DIAGRAM
MODEL 95A

SECTION IV

THEORY OF OPERATION

4.1-0 General

A simplified block diagram of the Model 95A is shown in Figure 1. The circuit consists of an input range switch, a filter to reduce the effect of the external pick-up, a chopper which converts the dc to ac at power-line frequency, a four stage negative feedback amplifier, a semi-conductor synchronous rectifier that restores the amplified ac to dc, a zero-center dc microammeter indicator, a cathode follower output amplifier, a synchronous rectifier to provide the dc output, and a power supply.

4.2-0 Range Switch

The input dc voltage or current is applied to two 7-position switches, which, on the five most sensitive voltage and current ranges, controls the feedback in the amplifier. On all other voltage ranges the input voltage is divided to 1 millivolt which is applied to the low pass filter. On current range from 300 picoamperes to 1.0 milliampere, shunt resistors are switched across the input to correlate the 1.0 millivolt with current. From the 3.0 milliampere range to the 1.0 ampere range, the input resistor remains 1.0 ohm and the voltage sensitivity is changed to calibrate the current ranges correctly. The input circuit has the ground carried through a connector contact to minimize ground loops and series resistance problems which may occur if ground were carried by the connector shell. The shielded input cable is terminated in insulated phone tips of beryllium copper to reduce thermal effects which occur when connecting conventional steel clips to brass or copper conductors.

4.3-0 Low Pass Filter

The range switch of the output of the range selector is connected to a multi-section low pass filter which attenuates unwanted 60 Hertz pick-up at least 60 dB. Frequencies above a few Hertz are also attenuated by the filter. This restricts the use of the 95A to dc or very low frequency ac applications. Because the amplifier is designed to amplify the low level 60 Hertz output of the chopper, the rejection of unwanted 60 Hertz voltages at the input is imperative.

4.4-0 Converter Chopper

The dc at the filter output is applied to a low-noise mechanical chopper which converts it to an alternating voltage of the same frequency as the ac power source. A bias voltage applied to one side of the chopper serves as the meter zero adjustment.

4.5-0 Amplifier

The chopper output is capacitively coupled to a two-stage low-noise, non-microphonic, dual-triode amplifier. The third stage is a high gain pentode which couples to a medium gain amplifier stage consisting of half of a dual triode. The remaining half of the dual triode operates as a cathode follower. The stages of the amplifier are R/C coupled. These coupling networks and associated filters have been designed for 50 to 60 Hertz operation with pronounced roll-off in gain outside this band. A portion of the output is applied out-of-phase to the first and third stages. The amount of this negative feed-back is selected by the range switch to give the required overall gain on each of the five most sensitive voltage and current ranges.

4.6-0 Synchronous Rectifier

The output of the cathode follower is applied to a transistor rectifier. The driving voltage for the transistor is so phased that the polarity of the rectified voltage is the same as the polarity of the voltage at the input of the instrument. The polarity and amplitude of the rectifier output are indicated on the 6-inch zero center meter.

4.7-0 Power Supply

The power supply circuits provide a regulated +150 volts for the plates of the tubes in the first four stages of the amplifier; +190 volts unregulated for the fifth amplifier stage and the cathode followers, and low voltage dc for the filaments of the first three stages of the amplifier. The remaining filaments are operated from 6.3 volts ac from the power transformer. A -14V bias voltage is also supplied for meter zeroing.

4.8-0 Cathode Follower

The ac voltage from the plate of the output amplifier is applied to a gain control (OUTPUT LEVEL -R26) which varies the input to the grid of one triode of a cathode follower. A synchronous rectifier converts the voltage from ac to dc. Output filtering is accomplished by a smoothing filter in the output circuit. The polarity and magnitude of the dc output is proportional to the dc input.

SECTION V

CALIBRATION & TEST PROCEDURE

5.1-0 Equipment Required:

Megohmmeter: Freed type 1020B or equivalent

Variable Transformer: Superior Electric Powerstat Type 2PF10 (1A) or equivalent

Resistance Bridge: Electro-Measurements Model 230R

DC Null Detector: Boonton Electronics Model 56A

VOM: Triplett Model 630A or equivalent

ACVTVM: Ballantine Model 314 or equivalent

Recorder: Rustrak Model A or equivalent

2200 Ω, 1/2W 5%
1000 Ω, 1/2W 5%

DC Voltage source, variable from 10μV to 1000 V ±0.5%

DC Attenuator in 20% steps

DC Current Source, variable from 1pA to 1 Ampere ±0.5%

5.2-0 Non-Operating Inspection

5.2-1 Meter Zero Adjustment

If the pointer is off zero, rotate the screw located in the center of meter case CCW or CW until the pointer rests at zero.

5.2-2 Remove the shorting link between ground and floating chassis posts and connect the megohmmeter across the posts. The measured resistance should be above 500 megohms.

5.3-0 Voltmeter Calibration

5.3-1 Set the ac operating voltage to 115 V, and allow instrument to warm up for at least 15 minutes. Reconnect shorting link. Be sure to use the adapter plug attached to the end of the line cord with the ground wire disconnected. This will open any major ground loops which may affect the instrument, particularly for low voltage measurements. It should be noted that under normal operating conditions, when the standard NEMA plug (three prong) is used, the grounded binding posts and black input cable clip are at power system ground potential.

NE

5.3-2 Electrical Zero Set

With input leads shorted and the range switches set for 1 mV full scale, set the zero control to center position. Adjust R98 located on top of amplifier chassis for zero voltage at the dc output terminals, then adjust R32 for a meter indication of zero.

5.3-3 With input cable removed and instrument turned on, set range to 1 mV. Measure the input resistance across #1 and #2 of input receptacle J2 using resistance bridge and dc null detector. If a reading of 10 megohms + 1/2% is not obtained the following adjustment must be made: Remove the two #8 screws on each side of the cabinet near the front panel. Remove the two #6 screws on the rear of the cabinet. The front panel and amplifier assembly can now be removed from the front of the cabinet. Remove the #4 screws securing the bottom plate to the amplifier and readjust the trimming capacitor C30 located at the base of the chopper socket XCH-1 with a non-metallic alignment tool.

Before proceeding with the test it is recommended that a check for + 190 VDC ± 10% between Amplifier Chassis and Pin 1 of V4 and + 150 VDC ± 3% between Amplifier Chassis and Standoff E1 (R9) be made.

Replace bottom plate and Amplifier Assembly in cabinet, and secure screws.

5.3-4 Connect the input cable to the input receptacle and short the black and red clips together. Set range to 300 µV and vary meter zero control (R86) from full CCW to CW. Meter should indicate approximately 30% of full scale on both sides of zero. Set range to 10 µV and reset to zero.

5.3-5 For accurate meter zeroing, the input cable should be connected to the same source impedance, with and without voltage present.

5.3-6 Set instrument to 10 µV range, set zero, and apply 10 µV, either polarity, from dc voltage source to input cable. Adjust #1 control located on lower right side of cabinet for full scale deflection. Reverse the polarity of test voltage and readjust #1 control if necessary to average the polarity reversing error if any exists. If an adjustment was necessary, meter zero must be rechecked and calibration repeated.

5.3-7 Repeat step 5.3-4 procedure for 30 µV range, adjust #2 control.

5.3-8 Repeat step 5.3-4 procedure for 100 μV range, adjust #3 control.

5.3-9 Repeat step 5.3-2 procedure for 300 μV range, adjust #4 control.

5.3-10 Repeat step 5.3-4 procedure for 1000 μV range, adjust #5 control.

5.3-11 Check all ranges from 1 mV to 1000 V for full scale accuracy + 3%. If the instrument is out of calibration on any range above 1 mV, repeat step 5.3-10 averaging out the error until all ranges from 1 mV to 1000 V are within the full scale accuracy of + 3%. This completes the calibration of the voltmeter.

5.4-0 Voltmeter and Amplifier Output Test

5.4-1 Set range to 10 μV and set zero; switch to 1 mV range; and apply dc voltage for full scale deflection; record positive and negative indication.

5.4-2 Reduce line voltage to 105 V, ac, and repeat 5.4-1.

5.4-3 Increase line voltage to 125 VAC and repeat 5.4-1. The change in readings between 5.4-1, 5.4-2, and 5.4-3 should not exceed 2% of 5.4-1. Reset line voltage to 115 V, ac.

5.4-4 Range set to 1 mV with zero input voltage, connect the 1000 ohm resistor in parallel with the VOM across the output terminals.

NOTE: There are no calibration adjustments for the current ranges. Current is measured by the 95A in terms of the voltage drop across precision resistors switched internally across the input terminals. Hence, the accuracy is dependent on both the precision of voltage indication and the precision of the shunt resistors.

5.4-5 Set the output level control to maximum and apply + 1 mV to input. The output voltage should be more than + 1V. Reverse polarity of input and VOM leads, output should be more than - 1V.

5.4-6 Decrease the output level to 1V output with output level control. Decrease input voltage by 20% steps to zero and increase in opposite polarity by 20% steps to 1 mV input. The instrument meter, and output level, non-linearity (or tracking error) should be less than 2% of full scale.

5.4-7 Apply +1 mV input and replace VOM with the AC VTVM. Output ripple should be less than 0.01 V, RMS.

5.5-0 Ammeter Test

5.5-1 Remove the 1000 ohm resistor and VOM from output posts. Remove the dc voltage source from input cable. Set range to the 1 μμA position and connect input cable to a dc current source.

Check all ranges from 1 μμA to 1000 mA. The full scale deflection should be within + 4% of full scale.

5.5-2 To check operation on the most sensitive current ranges, a voltage is applied in series with a high resistance. For example, applying 20 μV in series with 10 megohms (+ 1%) to the input of the instrument will produce a 10 μV drop across the input, if the input resistance is of the correct value. The meter will indicate 10 μV FS; since 1 A must flow under these conditions, it will correctly indicate 1 A, FS.

5.6-0 Amplifier Drift and Noise Test

5.6-1 Drift and noise measurements must be made after the instrument has been off at least one hour. If the shorting link has been removed for current measurements, it must be replaced at this time. Replace the 1K load across output terminals. On the 1 mV range apply + 1 mV input and adjust output level control for + 1 V output. Remove input voltage and replace input cable with a "U" shaped shorting bus across Pins 1 and 2 of input receptacle J2. Connect the output to a recorder. Set the sensitivity of the recorder to equal 1 volt, FS. Switch to 10 μV range and zero the meter. Start the recorder. (The distance between the recorder and instrument under test should exceed 2 feet. The strong AC field from the recorder or any other source may cause indications which will affect the calibration and checkout of the instrument.) After a 3 hour recording is completed, the recorded drift should be less than + 2 μV after the first hour. The noise (width of recorded output) measured any time after the first 1/2 hour should not be more than 1 μV peak to peak.

5.6-2 Zero Offset Test

With instrument set to 300 μV range and input open (cable removed), turn zero control to full CCW position. The meter should indicate more than -100 μV. Rotate zero control to full CW position, the meter should indicate more than +100 μV.

SECTION VI

TABLE OF REPLACEABLE PARTS

Reference		Description				BEC Part No.
C1	Capacitor, Mylar	0.022	µF	200	V	230,101
C2A	" Elec.	20	µF	475	V	283,109
C2B	" Elec.	50	µF	50	V	--
C2C	" Elec.	20	µF	25	V	--
C3	" Elec.	50	µF	6	V	283,145
C4	" Mylar	0.005	µF	200	V	230,121
C5	" Plastic	0.022	µF	200	V	234,040
C6	" Elec.	5	µF	6	V	283,108
C7	" Mylar	0.005	µF	500	V	230,121
C8	" Plastic	0.022	µF	200	V	234,040
C9	" Mylar	0.1	µF	200	V	230,116
C10	" Mylar	0.1	µF	200	V	230,116
C11	" Mylar	0.1	µF	200	V	230,116
C12	" Met.P.	1.0	µF	200	V	230,104
C13	" Elec.	50	µF	6	V	283,145
C14	" Elec.	5	µF	150	V	283,173
C15	" Elec.	20/100	µF	100	V	283,178
C16	" Elec.	25	µF	25	V	283,172
C17	" Elec.	25	µF	25	V	283,172
C19	" Met.P	0.05	µF	200	V	230,117
C25	" Mylar	0.022	µF	200	V	230,101
C26	" Mylar	0.022	µF	200	V	230,101
C27	" Mylar	0.1	µF	200	V	230,116
C28	" Mylar	0.1	µF	200	V	230,116
C29	" Sil.Mica	300	pF	500	V	201,128
C30	" Var.Mica	37-250	pF	500	V	275,118
C31	" Mylar	0.33	µF	200	V	234,032
C32A	" Elec.	20	µF	450	V	283,113
C32B	" Elec.	20	µF	450	V	--
C32C	" Elec.	20	µF	450	V	--
C33	" Elec.	5	µF	50	V	283,143
C34A	" Elec.	1000	µF	15	V	283,114
C34B	" Elec.	1000	µF	15	V	--
C35,36,37	" Ceramic	0.05	µF	100	V	224,117
CH-1	Chopper	BBM-Special				540,108 9/00
CR-1	Rectifier, Sel.	Sarkes-Tarzian #304B				532,001
D1	Diode, Zener	1N1775				530,026
D2	Diode, Zener	1N1775				530,026
D3	Diode, Zener	15V 1W 5%				530,046
D6	Diode, Silicon	1N251				530,043

Reference		Description				BEC Part No.
F1	Fuse	MDL 0.5 Amp				545,504
I1	Lamp	GE #323	3 V			545,106
I2	Lamp	GE #323	3 V			545,106
I3	Lamp	TS 47	6 V			545,101
I4	Lamp	TS 47	6 V			545,101
L1	Choke	Stancore #C1707	7 Hy			440,001
L2	Choke	Stancore #C1707	7 Hy			440,001
M1	Meter	Special 100-0-100 μA				554,137
Q1	Transistor	2N404A PNP				528,002
Q2	Transistor	2N404A PNP				528,002
R1	Resistor	6.8	Meg.	1/2W	5%	301,179
R2	"	1	Meg.	1/2W	1%*	306,598
R3	"	1	Meg.	1/2W	5%	301,159
R4	"	1	K	1/2W	5%	301,087
R5	"	47	K	1/2W	5%	301,127
R6	"	2.2	Meg.	1/2W	5%	301,167
R7	"	1	Meg.	1/2W	5%	301,159
R8	"	10	K	1/2W	5%	301,111
R9	"	47	K	1/2W	5%	301,127
R10	"	2.2	Meg.	1/2W	5%	301,167
R11	"	470	K	1/2W	5%	301,151
R12	"	1	Meg.	1/2W	5%	301,159
R13	"	2.2	Meg.	1/2W	5%	301,167
R14	"	100	K	1/2W	5%	301,135
R15	"	2.2	K	1/2W	5%	301,095
R16	"	1	Meg.	1/2W	5%	301,159
R17	"	470	Ω	1/2W	5%	301,079
R18	"	18	K	1/2W	5%	301,117
R19	" Dep.Car.	10	Meg.	1/2W	1%	306,635
R20	" Dep.Car.	10	Meg.	1/2W	1%	306,635
R23	"	10	K	1/2W	5%	301,111
R24	"	18	K	1/2W	5%	301,117
R26	" Variable	1	Meg	2 W	20% Level	311,133
R27	"	10	Ω	1/2W	5%	301,039
R28	"	3.3	K	1/2W	5%	301,099
R29	"	1	K	1/2W	5%	301,087
R31	"	200	Ω	1/2W	5%	301,070
R32	" Variable	50	Ω	2 W	10%	311,210
R33	"	6.8	K	1/2W	5%	301,107
R34	"	15	K	1/2W	5%	301,115
R35	"	470	K	1/2W	5%	301,151
R36	"	100	K	1/2W	5%	301,135

95A
4/19/66
b

Reference		Description					BEC Part No.
R37	Resistor	18	Ω	1/2W	5%		301,045
R38	"	330	K	1/2W	5%		301,147
R39	"	220	K	1/2W	5%		301,143
R40	"	8.92	Meg.	2 W	.5%*		323,501
R41	"	220	K	1/2W	5%		301,143
R42	"	100	K	1/2W	5%		301,135
R43	"	150	K	1/2W	5%		301,139
R44	"	2.2	K	1/2W	5%		301,095
R45	"	1	Meg.	1/2W	1%*		306,598
R46	"	1.5	K	1/2W	5%		301,091
R47	" Variable	1	K	2 W	20%	1 Adj.	311,100
R48	" Variable	2	K	2 W	20%	2 Adj.	311,114
R49	"	1.8	K	1/2W	5%		301,093
R50	" Variable	2	K	2 W	20%	3 Adj.	311,114
R51	" Variable	15	K	2 W	20%	4 Adj.	311,109
R52	"	22	K	1/2W	5%		301,119
R53	"	25	K	2 W	20%	5 Adj.	311,115
R54	"	33	K	1/2W	5%		301,123
R55	"	68	K	1/2W	5%		301,131
R56	"	233	Ω	1/2W	.5%*		321,009 - 56-E
R57	"	66.7	Ω	1/2W	.5%*		321,012 - 56-B
R58	"	23.3	Ω	1/2W	.5%*		321,007 - 56C
R59	"	6.67	Ω	1/2W	.5%*		321,006 - 56D
R60	"	2.33	Ω	1/2W	.5%*		321,005 - 56A
R61	"	1	Ω	3 W	.5%*		309,011
R62	"	244	K	1/2W	.5%*		321,508
R63	"	66.7	K	1/2W	.5%*		321,270
R64	"	23.3	K	1/2W	.5%*		321,269
R65	"	6.67	K	1/2W	.5%*		321,257
R66	"	2.33	K	1/2W	.5%*		321,268
R67	"	1	K	1/2W	.5%*		321,267
R68	"	3.9	Meg.	1/2W	.5%*		321,511
R69	"	1.1	Meg.	1/2W	.5%*		321,510
R70	"	6.67	K	1/2W	.5%*		321,257
R71	"	2.33	K	1/2W	.5%*		321,268
R72	"	667	Ω	1/2W	.5%*		321,010
R73	"	233	Ω	1/2W	.5%*		321,009
R74	"	66.7	Ω	1/2W	.5%*		321,012
R75	"	23.3	Ω	1/2W	.5%*		321,007
R76	"	10	Ω	1/2W	.5%*		321,004
R77	"	6.67	Meg.	1/2W	.5%*		322,501
R78	"	9	Meg.	1 W	.5%*		322,502
R79	"	9.66	Meg.	1 W	.5%*		322,503
R80	"	9.9	Meg.	1 W	.5%*		322,500
R81	"	5	Meg.	1/2W	.5%*		321,512
R82	"	1.1	Meg.	1/2W	.5%*		321,510
R83	"	345	K	1/2W	.5%*		321,509

Reference		Description				BEC Part No.
R84	Resistor	66.7	K	1/2W	.5%*	321,270
R85	"	23.3	K	1/2W	.5%*	321,269
R86	" Variable	50	K	2 W	20% Zero	311,125
R87	"	100	K	1/2W	5%	301,135
R88	"	15	K	1/2W	5%	301,115
R89	"	1	K	1/2W	5%	301,087
R90	"	1	K	1/2W	5%	301,087
R91	"	20	K	5.25W	5%	310,145
R92	"	1	Meg.	1 W	20%	302,128
R93	"	4.7	K	1 W	5%	302,117
R94	"	7.5	K	10 W	10% WW	312,100
R95	"	3.9	K	2 W	5%	304,101
R97	"	1.2	K	1/2W	10%	301,089
R98	"	250	K	1/10W	20%	311,122
R99	"	10	Ω	1/2W	5%	301,039
R100	"	10	Ω	1/2W	5%	301,039
R102	" Met.Film	3.9	K	1/2W	5%	315,002
R103	" Met.Film	3.9	K	1/2W	5%	315,002
S1	Switch	4 pole 7 pos. Special				466,136
S2	"	8 pole 7 pos. Special				466,137
S3	"	SPST Carling #110-63				465,105
T1	Transformer	Power, Special				446,007
V1	Electron Tube	12AX7 Special 3.[illegible]				525,001
V2	"	6AU6				526,6AU6
V3	"	12AT7				526,12AT7
V4	"	12AT7 Special 5.28				525,002
V5	"	6X4				526,6X4
V6	"	OA2				526,OA2

Warranty

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty. Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

BOONTON ELECTRONICS CORPORATION

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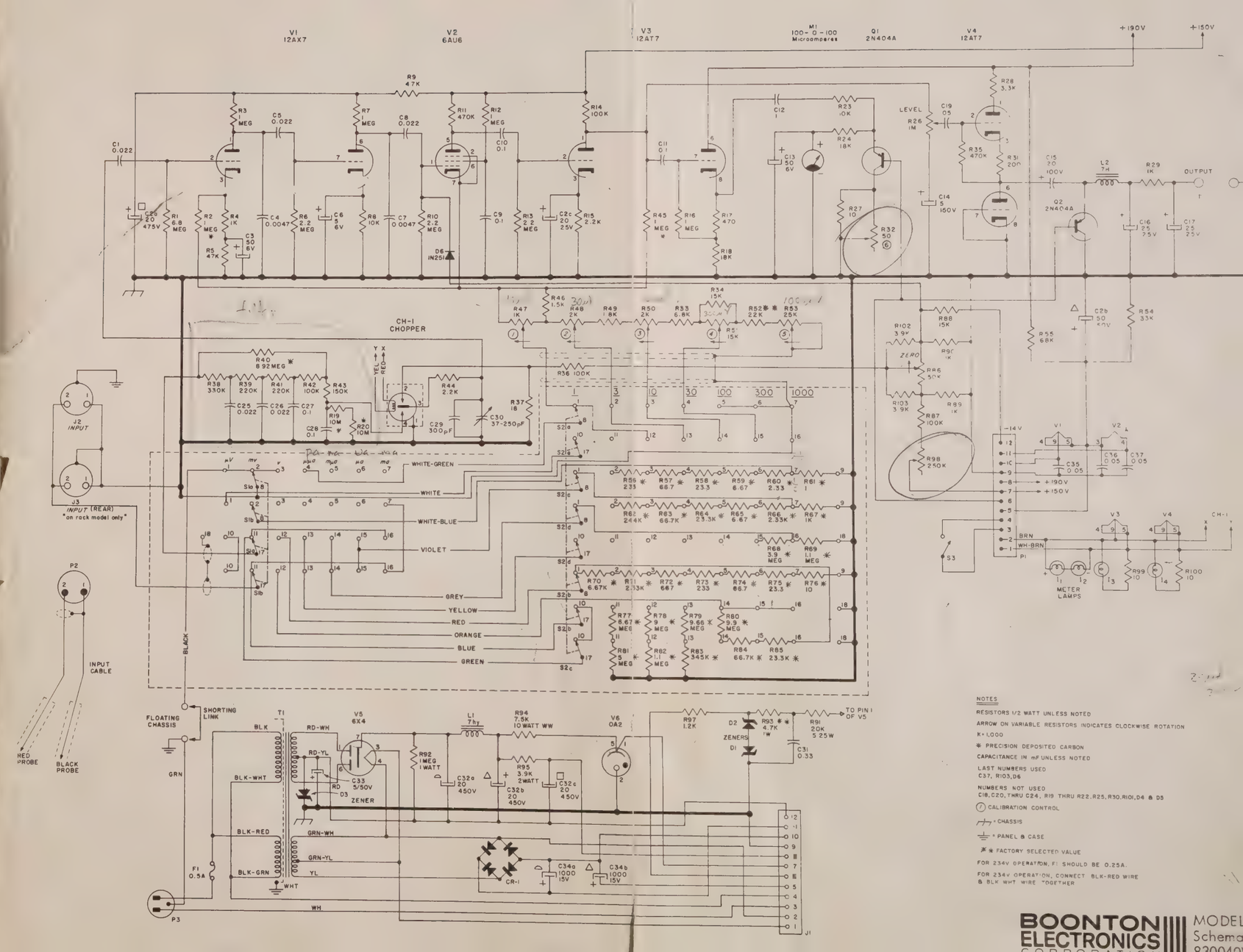
TWX: 710-986-8241
Route 287, Parsippany, N. J. – 07054



NOTES

RESISTORS 1/2 WATT UNLESS NOTED

ARROW ON VARIABLE RESISTORS INDICATES CLOCKWISE ROTATION

K = 1,000

* PRECISION DEPOSITED CARBON

CAPACITANCE IN mF UNLESS NOTED

LAST NUMBERS USED
C37, R103, D6

NUMBERS NOT USED
C18, C20, THRU C24, R19 THRU R22, R25, R30, R101, D4 & D5

(1) CALIBRATION CONTROL

= CHASSIS

= PANEL & CASE

** FACTORY SELECTED VALUE

FOR 234V OPERATION, F1 SHOULD BE 0.25A.

FOR 234V OPERATION, CONNECT BLK-RED WIRE & BLK WHT WIRE TOGETHER

BOONTON ELECTRONICS CORPORATION

MODEL
Schema
820040

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